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ANEQ-1
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Estimated Cost of HARVEST System

R/D --- M/O

1. The Preliminary Manual on HARVEST System proposes (pg. 9.10) that the basic System include the following units:

- a) One Harvest Computer ✓
- b) Eight units of 8,192 words of 2.0 microsecond memory ✓
- c) Four units of 512 words of 0.5 microsecond memory ✓
- d) Sixteen single word registers with 0.1 microsecond access time
- e) One Exchange
- f) One 1000 card per minute card reader
- g) One 155 card per minute card punch
- h) One 500 line per minute printer
- i) Six high performance tape mechanisms ✓
- j) One high performance disk memory X
- k) Four tape units handling IBM 727 tapes +
- l) One console with manual inquiry station

2. Of the above units, five (items f, g, h, j, and k) can be categorized as "commercially available" at present or by the time of the System's delivery. Further, because of their use of multiple identical copies, certain units being developed for HARVEST (items b, c, d, i) can be assumed to be reproducible under production conditions. Another important unit, the Exchange (item e) has been

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developed simultaneously for Atomic Energy Commission's computer and for HARVEST; the cost of constructing the data-flow model has already been charged to the account of A.E.C. It is therefore reasonable to charge the cost of the Exchange unit construction, in the HARVEST System, as a "non-R/D" item of expense.

3. The following information summarizes the present state of our knowledge as to the engineering and logical sophistication or complexity of the units subject to R/D support:

a. HARVEST Computer. All-transistorized (approx. 100,000 transistors) serial-parallel computer capable of carrying out basic logical and arithmetic operations at a rate of 10 million per second. It includes numerous control features and counters, matrices, and storage registers designed to efficiently perform NSA analytic functions such as modular operations, operations on pairs of streams of characters, statistical testing and sorting. Although much of the logic represents efficient ways of streamlining computer operations in general, such as the exchange unit, automatic indexing, and memory speed-up, the greatest improvements for NSA uses, over existing computers, appear in the stream units, modular operations, and the system of address assembly and table extraction, which were specifically planned to meet problem requirements exclusive to N.S.A. Although listed separately, the Console should be included with the "computer" for the purpose of this discussion.

b. Memory and Bus System. Although memory research was well under way before the beginning of NSA support, much of the work on memory speed-up has been supported by NSA funds, under Task 11, SILO. Furthermore, an important feature of the FARMER system concept has been the requirement for tying in units of varying degrees of specialization, for joint operation in problem analysis. The proposed feature which makes this possible, and permits relatively unrelated units to share information, is the assembly of memory in "blocks" and their interconnection with computer, exchange and other units by a "bus" system which permits a certain amount of simultaneous data transmission of words in parallel. The bus system will have to be rather elaborate to allow for maximum estimates of "traffic flow" of information. As for the memory units themselves, once the feasibility of a block of the 2 microsecond and the 0.5 microsecond memory is demonstrated, construction of additional blocks of memory can be properly justified as "additional identical" construction. Although not usually thought of as part of computer memory, similar remarks probably apply to the 0.1 microsecond one-word transistor registers.

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c. High-Performance Tape Mechanisms. As in the case of memory developments, the research work in several areas leading to production of high-performance tape mechanisms has been only partly supported by NSA. These equipments are important in our overall system since they offer the only hope of attacking many classes of problems, because excessive volume and speed considerations make previous equipment totally inadequate. The goal in processing rate is a minimum of 10 million bits per second per reel, attained by increasing packing density to several thousand bits/inch and passing tape at the rate of about 300 inches/second. Storage capacity will be in the range of 10-12 billion bits total for all six mechanisms. Automatic reel-loading methods are among the features under development.

4. It is understood that IBM pricing policy will probably not agree with our basis, because that company has invested research money, and probably wishes to retain some proprietary interest in many of the developments. In order for us to arrive at some basis for estimating the worth of a system of equipment like HARVEST, however, several points of view can be examined:

a. Compare HARVEST operating capability with a current computer, like the EDPM Type 704, and apply that factor to the cost of the 704. An estimate of this kind can be arrived at by estimating HARVEST to be 100 times the power of a 704 which may be priced at about ~~\$300~~ million; HARVEST value: \$300,000,000.

± 3

b. Assume a labor force of between 50 and 100 engineers and technicians, working for an expected three-year period. This staff has been intimated by IBM representatives in previous discussions. A basis for estimating machine cost which has been reasonably correct in the past, assumes the total cost to be about three times the estimated labor cost. Table I, "Overall System Estimate" develops this basis for an estimate, which turns out to be \$18.75 million.

c. To arrive at a suitable dissection of parts of the system into R/D and M/O items, another basis for an estimate is the actual or probable rentals of separate items in the system. A ratio of "50 times the one-shift rental" yielded the sale prices shown in Table II, "R/D vs M/O". The separation into R/D or M/O follows the justification given in par. 2, above, with the R/D entry including NSA research support to date. This results in a total system estimate of \$21.92 million, divided into \$8.3 million for R/D and \$13.62 for M/O. It should be realized that this cost estimate represents a marketing price, including profit. Column headed "AEC" lists comparable estimated costs of the units understood to be included in the equipment to be delivered to AEC in May 1960. This AEC total of \$13,190,000 should be compared with their contract price of \$4,300,000.

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5. Before final decisions are made regarding negotiation of a fixed-price contract, another possible basis should be studied. This is based upon IBM's unofficial estimate of an expenditure of about \$2 million per year for 2-1/2 to 3 years to construct HARVEST. It is understood that, if R/D support at this level can be assured, the same equipment can be delivered in the same period. This basis might result in a total cost to NSA of seven to eight million dollars, including research money spent to date.

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TABLE I
OVERALL SYSTEM
ESTIMATE

	Jy.-Dec. 57	Jan.-Dec. 58	Jan.-Dec. 59	Jan.-Jy. 60
Engr's Years	50 1/2	100 1	100 1	50 1/2
Engr. Yrs.	25	100	100	25
Total Engr. Yrs.	= 250			

ASSUME

Labor = \$25/Engr. Yr.

Machine = 1/3 Labor Cost x 3

Machine Cost = (250 E.Y.) $\frac{(25 \times 10^3)}{\text{E.Y.}}$ $(\frac{1}{.33})$

= \$18.75 million

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TABLE II

UNIT COSTS, BASED ON RENTAL ESTIMATES x 50

NSA: R/D vs M/O, and AEC

ITEM	TOT.	NUMBER			COST + 1000		
		NSA	AEC		NSA	AEC	
		R/D	M/O		R/D	M/O	
Computer	1	1	0	1	5,000*		4,000*
Memory - M.S.	8	1	7	4	1,100	7,000	4,000
Memory - H.S.	4	1	3	2	1,700	3,000	2,000
Register - H.S.	16	1	15	16	70	1,050	1,120
Exchange	1	0	1	1		1,500	1,500
Card Punch	1	0	1	1		50	50
Card Reader	1	0	1	1		50	50
Printer	1	0	1	1		100	100
Mag. Tape - H.P.	6	1	5	0	430	500	
Mag. Tape 727	4	0	4	4		120	120
Mag. Disc. - H.P.	1	0	1	1		250	250
TOTAL					8,300	13,620	
NSA TOTAL						21,920	
AEC TOTAL							13,190

* The difference in estimated cost of NSA vs AEC Computer portion is based upon the following:

DEVELOPMENT: About a year, and \$600,000 have been devoted to generating the special features required by the NSA problem study. AEC logical development effort will be almost negligible.

CONSTRUCTION COST: HARVEST design provides for three Stream Units, complex automatic addressing and table extraction, and elaborate indexing. AEC's computer will not require these features, but will have a high-speed arithmetic unit not expected to be in HARVEST. Estimated additional construction cost of HARVEST: \$400,000.

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